Observations on the Change of some of the proximate Principles of Vegetables into Bitumen; with analytical Experiments on a peculiar Substance which is found with the Bovey Coal. By Charles Hatchett, *Esq. F.R.S.* Read June 14, 1804. [*Phil. Trans.* 1804, *p.* 385.]

Among the several spontaneous permutations in the productions of nature, none perhaps are more striking, and in many cases more unaccountable, than those which transfer bodies from one kingdom of nature into another: and those changes which transform organized into fossil substances are certainly not the least extraordinary and instructive.

The most numerous instances of this transformation are, no doubt, what we distinguish by the name of *Extraneous Fossils;* some of which still retain part of their original substance, whilst others can only be regarded as casts or impressions. An attentive observer will soon perceive a kind of gradation in these fossils, whether from animals or vegetables, commencing with those whose matter retains a marked analogy with that of the recent substances, and terminating in bodies decidedly mineral. And a curious remark occurs here,—that as animal petrifactions are most commonly of a calcareous nature, so, on the contrary, vegetable petrifactions are generally siliceous.

Without entering any further into a general disquisition on this important subject, our author proposes to discuss, in this paper, one particular case of the changes which organized, and especially vegetable, substances undergo, by being long buried in earthy strata, and thus exposed to the effects of mineral agents: and the instance he selects is the bituminous substances, concerning which he has long suspected that they are derived from the organized kingdoms, and especially from the resin and juices of vegetable substances, by the action of some of the mineral principles.

He cites three instances in this kingdom in which nature points out these changes, and which exhibit the gradations above intimated. These are,—1. The submarine forest at Sutton, on the coast of Lincolnshire, the timber of which has not suffered any very apparent change in its vegetable characters; 2. The strata of bituminous wood (called Bovey Coal) found at Bovey, in Devonshire, which exhibit a series of gradations, from the most perfect ligneous texture to a substance nearly approaching to the characters of pit-coal; and 3. All the varieties of pit-coal, so abundant in many parts of this country, in which almost every appearance of vegetable origin has been obliterated.

As the Bovey coal appears to be the mean in that gradation, and therefore most likely to afford instructive results, our author resolved to limit his inquiry into this process of nature, which may not improperly be called Carbonization, to that fossil, and to a peculiar bituminous substance with which it is often accompanied. But here he finds it expedient to premise some observations on a remarkable

schistus found at Reykum, one of the great spouting hot springs in Iceland. The singularity of this substance is, that a great part of it consists of leaves, (evidently those of the alder,) interposed between the different lamellæ. These leaves appeared to be in the state of charcoal; but on more close examination, no doubt remained of their still retaining a certain portion of some of the other principles of the original vegetable, such as extract and resin. This, in fact, is the result of an extensive chemical process, from which we learn that the schistus, taken collectively, yields, besides silicia, alumina, and oxide of iron, a certain proportion of water and of vegetable matter, and that it evidently belongs to the family of argillaceous schistus.

The above process may be considered as preliminary to that on the Bovey coal, in which the vegetable characters are more obliterated than in the leaves of the schistus. This coal, we are told, bears a great resemblance to a fossil found in Iceland, called Surturbrand; the strata of both being composed of trunks of trees, which have completely lost their cylindrical form, and are flattened, as if they had been subjected to an immense degree of pressure. On inquiring into this last-mentioned circumstance, our author produces his reasons for believing that it is not the effect of the mere pressure of a superincumbent stratum, but also of a certain change in the solidity of the vegetable bodies, and a powerful mechanical action, produced by the contraction of the argillaceous strata in consequence of desiccation.

Here follows the analysis of the Bovey coal. The results point out a great resemblance between this substance and that which forms the leaves contained in the Iceland schistus. The only exception is, that the leaves contain some vegetable extract, none of which could be discovered in the coal. Both consist of woody fibre in a state of semicarbonization, impregnated with bitumen and a small portion of resin, perfectly similar to that which is contained in many recent vegetable characters, and is but partially and imperfectly converted into coal; so, in like manner, some of the other vegetable principles have only suffered a partial change. Next to this woody fibre, resin is thought to be the substance which, in vegetables passing to the fossil state, most powerfully resists any alteration, and which, when this change is at length effected, is more immediately the substance from which bitumen is produced.

This opinion, that the vegetable extract and resin are the parts of the original vegetables, which retain their nature after other portions of the same have been modified into bitumen, is corroborated by the analysis which here follows, of a singular substance which is found with the Bovey coal. Dr. Milles, who first mentioned this substance, considered it as a loam saturated with petroleum; but our author, on mere inspection, decided that it is not a loam, but a peculiar bituminous substance. After a description of its external appearances, and some of its relative properties, we come to the analysis; from which we collect, that this is a peculiar and hitherto unknown substance, which is partly in the state of vegetable resin, and partly in

that of the bitumen called Asphaltum; the resin being in the largest proportion, 100 grains affording 55 of resin, and 44 of asphaltum. Thus we have an instance of a substance found under circumstances which constitute a fossil, although the character of it partly appertain to the vegetable and partly to the mineral kingdom

In the concluding section the author enters into an inquiry on the action of alcohol on resins and bitumens. Its power of dissolving the former is well known; but, contrary to the adopted opinion, he found that it also acted on bitumen, though indeed in a slight degree. His chief object was to ascertain whether a small portion of resin is contained in any of the bitumens, or, if not, to determine the nature of the substance which can be separated, although very sparingly, from those substances by digestion in alcohol. The results prove that the small portion which can be extracted from bitumen by digestion with alcohol is petroleum.

From a general view of the subject, the author thinks himself justified in asserting, that in bitumens the process of transformation appears to have been completed; whereas in the Bovey coal, and especially in the substance which accompanies it, Nature seems to have performed only half of her work, and, from some unknown cause, to have stopped in the middle of her operations. By this circumstance, however, much light is thrown on the history of bituminous substances; and the opinion that they owe their origin to the organized kingdoms of nature, and especially to the vegetable, which hitherto had been supported only by presumptive proofs, seems now to receive a full confirmation, although the causes which operate these changes on vegetable bodies are as yet undiscovered.

On two Metals, found in the black Powder remaining after the Solution of Platina. *By* Smithson Tennant, *Esq. F.R.S.* Read June 21, 1804. [*Phil. Trans.* 1804, *p.* 411.]

From a few experiments the author made in the course of last summer on this powder, he concluded, that it does not, as was generally believed, consist chiefly of plumbago, but that it contains also some other unknown metallic ingredient. Since those experiments, two French chemists, Messrs. Descotils and Vauquelin, having likewise examined that substance, found the same new metal; but neither of them observed that it contains moreover another metal different from any hitherto known.

The black powder used in the process, which is the subject of this paper, was obtained from platina carefully separated from all extraneous particles; so that the above ingredients, if found, must have been contained in that metal.

The first set of experiments relates to the effects produced by this powder when alloyed with other metals. It combines readily with lead; but the compound, even when the lead greatly predominates, is not very fusible. With bismuth, zinc, and tin, the effects are nearly similar; but with copper, a strong heat produces a much more